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Interplay between antiferromagnetic and Kondo-breakdown quantum critical points in pure and doped $YbRh_2Si_2$

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In the heavy-fermion metal $YbRh_2Si_2$ a quantum critical point (QCP) has been established by driving a continuous antiferromagnetic (AF) phase transition from $T_N \approx 70$ mK at $B = 0$ to $T_N = 0$ via application of a tiny magnetic field B_N ($\perp$c) ≈ 60 mT. New results on the Hall coefficient [1], magnetic Grüneisen ratio [2] and thermoelectric power [3] support the conclusion drawn from earlier studies that this AF QCP coincides with a Kondo-breakdown QCP. In a recent investigation, positive and negative chemical pressure was applied to $YbRh_2Si_2$ to explore the evolution of its $B - T$ phase diagram under changes of the unit-cell volume [4]: Clear signatures of the Kondo-breakdown QCP were observed within the magnetically ordered phase under volume compression (i.e., Co substitution for Rh). Here, the AF QCP appears to be of the conventional (3D SDW) type. Under slight volume expansion (doping with 2.5 at % Ir) the AF instability and the Kondo-breakdown QCP were found to still coincide at B_N ($\perp$c) ≈ 40 mT. For 6 at% Ir doping, however, AF order appears to be largely suppressed ($B_N \approx 15$ mT), while the Kondo-breakdown QCP remains virtually unchanged. For this composition, a new low-T spin-liquid-type phase shows up at low temperatures in a finite range of magnetic fields. In collaboration with: M. Brando, S. Friedemann, P. Gegenwart, C. Geibel, S. Hartmann, S. Kirchner, C. Krellner, M. Nicklas, N. Oeschler, S. Paschen, Q. Si, O. Stockert, Y. Tokiwa, T. Westerkamp and S. Wirth.

[1] S. Friedemann et al., to be published.
[2] Y. Tokiwa et al., Phys. Rev. Lett. 102, 066401 (2009).
[3] S. Hartmann et al., to be published.
[4] S. Friedemann et al., Nature Phys. 5, 465 (2009).